November 15, 2007

# LM120/LM320
# Series 3-Terminal Negative Regulators

## General Description

The LM120 series are three-terminal negative regulators with a fixed output voltage of −5V, −12V, and −15V, and up to 1.5A load current capability. Where other voltages are required, the LM137 and LM137HV series provide an output voltage range of −1.2V to −47V.

The LM120 need only one external component—a compensation capacitor at the output, making them easy to apply. Worst case guarantees on output voltage deviation due to any combination of line, load or temperature variation assure satisfactory system operation.

Exceptional effort has been made to make the LM120 Series immune to overload conditions. The regulators have current limiting which is independent of temperature, combined with thermal overload protection. Internal current limiting protects against momentary faults while thermal shutdown prevents junction temperatures from exceeding safe limits during prolonged overloads.

Although primarily intended for fixed output voltage applications, the LM120 Series may be programmed for higher output voltages with a simple resistive divider. The low quiescent drain current of the devices allows this technique to be used with good regulation.

## Features

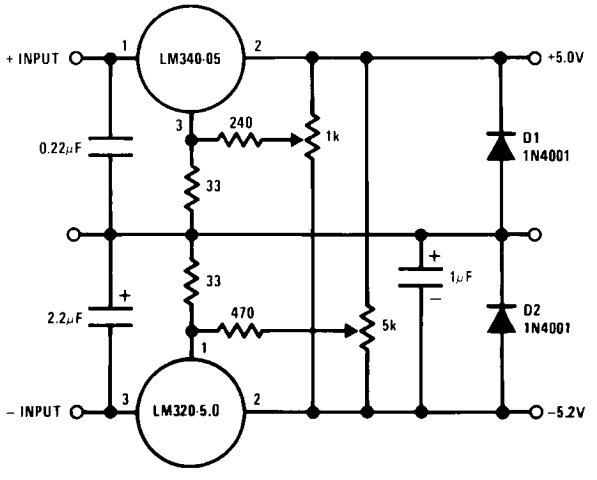
- Preset output voltage error less than ±3%
- Preset current limit
- Internal thermal shutdown
- Operates with input-output voltage differential down to 1V
- Excellent ripple rejection
- Low temperature drift
- Easily adjustable to higher output voltage

**LM120 Series Packages and Power Capability**

| Device | Package | Rated Power Dissipation | Design Load Current |
|---|---|---|---|
| LM120/LM320 | TO-3 (K) | 20W | 1.5A |
| | TO-39 (H) | 2W | 0.5A |
| LM320 | TO-220 (T) | 15W | 1.5A |

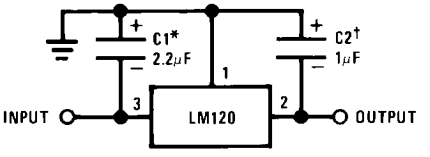
## Typical Applications

**Dual Trimmed Supply**




776703

**Fixed Regulator**

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*Required if regulator is separated from filter capacitor by more than 3 inches. For value given, capacitor must be solid tantalum. 25 μF aluminum electrolytic may be substituted.

†Required for stability. For value given, capacitor must be solid tantalum. 25 μF aluminum electrolytic may be substituted. Values given may be increased without limit.

For output capacitance in excess of 100 μF, a high current diode from input to output (1N4001, etc.) will protect the regulator from momentary input shorts.

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## Absolute Maximum Ratings

## –5 Volt Regulators (Notes 5, 3)

**If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.**

| | |
|---|---|
| Power Dissipation | Internally Limited |
| Input Voltage | –25V |
| Input-Output Voltage Differential | 25V |
| Junction Temperatures | (Note 1) |
| Storage Temperature Range | –65°C to +150°C |
| Lead Temperature | |
| (Soldering, 10 sec.) | 300°C |
| Plastic | 260°C |

## –5 Volt Regulators Electrical Characteristics (Note 3)

| Order Numbers | | Metal Can Package | | | | | | Units |
|---|---|---|---|---|---|---|---|---|
| | | LM120K-5.0 (TO-3) | | | LM320K-5.0 (TO-3) | | | |
| Design Output Current ($I_D$) Device Dissipation ($P_D$) | | 1.5A 20W | | | | | | |
| **Parameter** | **Conditions** (Note 1) | **Min** | **Typ** | **Max** | **Min** | **Typ** | **Max** | |
| Output Voltage | $T_J$ = 25°C, $V_{IN}$ =10V, $I_{LOAD}$ = 5 mA | –5.1 | –5 | –4.9 | –5.2 | –5 | –4.8 | V |
| Line Regulation | $T_J$ = 25°C, $I_{LOAD}$ = 5 mA, $V_{MIN} \le V_{IN} \le V_{MAX}$ | | 10 | 25 | | 10 | 40 | mV |
| Input Voltage | | –25 | | –7 | –25 | | –7 | V |
| Ripple Rejection | f = 120 Hz | 54 | 64 | | 54 | 64 | | dB |
| Load Regulation, (Note 2) | $T_J$ = 25°C, $V_{IN}$ = 10V, 5 mA $\le I_{LOAD} \le I_D$ | | 50 | 75 | | 60 | 100 | mV |
| Output Voltage, (Note 1) | –7.5V $\le V_{IN} \le V_{MAX}$, 5 mA $\le I_{LOAD} \le I_D$, P $\le P_D$ | –5.20 | | –4.80 | –5.25 | | –4.75 | V |
| Quiescent Current | $V_{MIN} \le V_{IN} \le V_{MAX}$ | | 1 | 2 | | 1 | 2 | mA |
| Quiescent Current Change | $T_J$ = 25°C | | | | | | | |
| | $V_{MIN} \le V_{IN} \le V_{MAX}$ | | 0.1 | 0.4 | | 0.1 | 0.4 | mA |
| | 5 mA $\le I_{LOAD} \le I_D$ | | 0.1 | 0.4 | | 0.1 | 0.4 | mA |
| Output Noise Voltage | $T_A$ = 25°C, $C_L$ = 1 µF, $I_L$ = 5 mA, $V_{IN}$ = 10V, 10 Hz ≤ f ≤ 100 kHz | | 150 | | | 150 | | µV |
| Long Term Stability | | | 5 | 50 | | 5 | 50 | mV |
| Thermal Resistance | | | | | | | | |
| Junction to Case | | | | 3 | | | 3 | °C/W |
| Junction to Ambient | | | | 35 | | | 35 | °C/W |

## –5 Volt Regulators
## Electrical Characteristics (Note 3)

| Order Numbers | | Metal Can Package | | | | | | Units |
|---|---|---|---|---|---|---|---|---|
| | | LM120H-5.0 (TO-39) | | | LM320H-5.0 (TO-39) | | | |
| Design Output Current ($I_D$) Device Dissipation ($P_D$) | | 0.5A 2W | | | | | | |
| **Parameter** | **Conditions** (Note 1) | **Min** | **Typ** | **Max** | **Min** | **Typ** | **Max** | |
| Output Voltage | $T_J$ = 25°C, $V_{IN}$ =10V, $I_{LOAD}$ = 5 mA | –5.1 | –5 | –4.9 | –5.2 | –5 | –4.8 | V |
| Line Regulation | $T_J$ = 25°C, $I_{LOAD}$ = 5 mA, $V_{MIN} \le V_{IN} \le V_{MAX}$ | | 10 | 25 | | 10 | 40 | mV |
| Input Voltage | | –25 | | –7 | –25 | | –7 | V |
| Ripple Rejection | f = 120 Hz | 54 | 64 | | 54 | 64 | | dB |
| Load Regulation, (Note 2) | $T_J$ = 25°C, $V_{IN}$ = 10V, 5 mA $\le I_{LOAD} \le I_D$ | | 30 | 50 | | 30 | 50 | mV |
| Output Voltage, (Note 1) | –7.5V $\le V_{IN} \le V_{MAX}$, 5 mA $\le I_{LOAD} \le I_D$, P $\le P_D$ | –5.20 | | –4.80 | –5.25 | | –4.75 | V |
| Quiescent Current | $V_{MIN} \le V_{IN} \le V_{MAX}$ | | 1 | 2 | | 1 | 2 | mA |
| Quiescent Current Change | $T_J$ = 25°C | | | | | | | |
| | $V_{MIN} \le V_{IN} \le V_{MAX}$ | | 0.05 | 0.4 | | 0.05 | 0.4 | mA |
| | 5 mA $\le I_{LOAD} \le I_D$ | | 0.04 | 0.4 | | 0.04 | 0.4 | mA |
| Output Noise Voltage | $T_A$ = 25°C, $C_L$ = 1 µF, $I_L$ = 5 mA, $V_{IN}$ = 10V, 10 Hz ≤ f ≤ 100 kHz | | 150 | | | 150 | | µV |
| Long Term Stability | | | 5 | 50 | | 5 | 50 | mV |
| Thermal Resistance | | | | | | | | |
| Junction to Case | | | | (Note 4) | | | (Note 4) | °C/W |
| Junction to Ambient | | | | (Note 4) | | | (Note 4) | °C/W |

## –5 Volt Regulators
## Electrical Characteristics (Note 3)

| Order Numbers | | Power Plastic Package | | | Units |
|---|---|---|---|---|---|
| | | LM320T-5.0 (TO-220) | | | |
| Design Output Current ($I_D$) Device Dissipation ($P_D$) | | 1.5A 15W | | | |
| **Parameter** | **Conditions** (Note 1) | **Min** | **Typ** | **Max** | |
| Output Voltage | $T_J$ = 25°C, $V_{IN}$ =10V, $I_{LOAD}$ = 5 mA | –5.2 | –5 | –4.8 | V |
| Line Regulation | $T_J$ = 25°C, $I_{LOAD}$ = 5 mA, $V_{MIN} \le V_{IN} \le V_{MAX}$ | | 10 | 40 | mV |
| Input Voltage | | –25 | | –7.5 | V |
| Ripple Rejection | f = 120 Hz | 54 | 64 | | dB |
| Load Regulation, (Note 2) | $T_J$ = 25°C, $V_{IN}$ = 10V, 5 mA $\le I_{LOAD} \le I_D$ | | 50 | 100 | mV |
| Output Voltage, (Note 1) | –7.5V $\le V_{IN} \le V_{MAX}$, 5 mA $\le I_{LOAD} \le I_D$, P $\le P_D$ | –5.25 | | –4.75 | V |
| Quiescent Current | $V_{MIN} \le V_{IN} \le V_{MAX}$ | | 1 | | mA |
| Quiescent Current Change | $T_J$ = 25°C | | | | |
| | $V_{MIN} \le V_{IN} \le V_{MAX}$ | | 0.1 | 0.4 | mA |
| | 5 mA $\le I_{LOAD} \le I_D$ | | 0.1 | 0.4 | mA |
| Output Noise Voltage | $T_A$ = 25°C, $C_L$ = 1 µF, $I_L$ = 5 mA, $V_{IN}$ = 10V, 10 Hz $\le$ f $\le$ 100 kHz | | 150 | | µV |
| Long Term Stability | | | 10 | | mV |
| Thermal Resistance | | | | | |
| Junction to Case | | | 4 | | °C/W |
| Junction to Ambient | | | 50 | | °C/W |

**Note 1:** This specification applies over –55°C $\le T_J \le$ +150°C for the LM120 and 0°C $\le T_J \le$ +125°C for the LM320.

**Note 2:** Regulation is measured at constant junction temperature. Changes in output voltage due to heating effects must be taken into account separately. To ensure constant junction temperature, low duty cycle, pulse testing is used. The LM120/LM320 series does have low thermal feedback, improving line and load regulation. On all other tests, even though power dissipation is internally limited, electrical specifications apply only up to $P_D$.

**Note 3:** For –5V 3 amp regulators, see LM145 data sheet.

**Note 4:** Thermal resistance of typically 85°C/W (in 400 linear feet air flow), 224°C/W (in static air) junction to ambient, of typically 21°C/W junction to case.

**Note 5:** Refer to RETS120-5H drawing for LM120H-5.0 or RETS120-5K drawing for LM120-5K military specifications.

## Absolute Maximum Ratings

## −12 Volt Regulators (Note 9)

**If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.**

| | |
|---|---|
| Power Dissipation | Internally Limited |
| Input Voltage | −35V |
| Input-Output Voltage Differential | 30V |
| Junction Temperatures | (Note 6) |
| Storage Temperature Range | −65°C to +150°C |
| Lead Temperature (Soldering, 10 sec.) | 300°C |

## −12 Volt Regulators Electrical Characteristics

| Order Numbers | | Metal Can Package | | | | | | Units |
|---|---|---|---|---|---|---|---|---|
| | | LM120K-12 (TO-3) | | | LM320K-12 (TO-3) | | | |
| Design Output Current ($I_D$) Device Dissipation ($P_D$) | | 1A 20W | | | | | | |
| **Parameter** | **Conditions** (Note 6) | **Min** | **Typ** | **Max** | **Min** | **Typ** | **Max** | |
| Output Voltage | $T_J$ = 25°C, $V_{IN}$ = 17V, $I_{LOAD}$ = 5 mA | −12.3 | −12 | −11.7 | −12.4 | −12 | −11.6 | V |
| Line Regulation | $T_J$ = 25°C, $I_{LOAD}$ = 5 mA, $V_{MIN} \le V_{IN} \le V_{MAX}$ | | 4 | 10 | | 4 | 20 | mV |
| Input Voltage | | −32 | | −14 | −32 | | −14 | V |
| Ripple Rejection | f = 120 Hz | 56 | 80 | | 56 | 80 | | dB |
| Load Regulation, (Note 7) | $T_J$ = 25°C, $V_{IN}$ = 17V, 5 mA $\le I_{LOAD} \le I_D$ | | 30 | 80 | | 30 | 80 | mV |
| Output Voltage, (Note 6) | 14.5V $\le V_{IN} \le V_{MAX}$, 5 mA $\le I_{LOAD} \le I_D$, P $\le P_D$ | −12.5 | | −11.5 | −12.6 | | −11.4 | V |
| Quiescent Current | $V_{MIN} \le V_{IN} \le V_{MAX}$ | | 2 | 4 | | 2 | 4 | mA |
| Quiescent Current Change | $T_J$ = 25°C | | | | | | | |
| | $V_{MIN} \le V_{IN} \le V_{MAX}$ | | 0.1 | 0.4 | | 0.1 | 0.4 | mA |
| | 5 mA $\le I_{LOAD} \le I_D$ | | 0.1 | 0.4 | | 0.1 | 0.4 | mA |
| Output Noise Voltage | $T_A$ = 25°C, $C_L$ = 1 µF, $I_L$ = 5 mA, $V_{IN}$ = 17V, 10 Hz ≤ f ≤ 100 kHz | | 400 | | | 400 | | µV |
| Long Term Stability | | | 12 | 120 | | 12 | 120 | mV |
| Thermal Resistance | | | | | | | | |
| Junction to Case | | | | 3 | | | 3 | °C/W |
| Junction to Ambient | | | | 35 | | | 35 | °C/W |

## −12 Volt Regulators Electrical Characteristics

| Order Numbers | | Metal Can Package | | | | | | Units |
|---|---|---|---|---|---|---|---|---|
| | | LM120H-12 (TO-39) | | | LM320H-12 (TO-39) | | | |
| Design Output Current ($I_D$) Device Dissipation ($P_D$) | | 0.2A 2W | | | | | | |
| **Parameter** | **Conditions** (Note 6) | **Min** | **Typ** | **Max** | **Min** | **Typ** | **Max** | |
| Output Voltage | $T_J$ = 25°C, $V_{IN}$ = 17V, $I_{LOAD}$ = 5 mA | −12.3 | −12 | −11.7 | −12.4 | −12 | −11.6 | V |
| Line Regulation | $T_J$ = 25°C, $I_{LOAD}$ = 5 mA, $V_{MIN} \le V_{IN} \le V_{MAX}$ | | 4 | 10 | | 4 | 20 | mV |

| Order Numbers | | Metal Can Package | | | | | | Units |
|---|---|---|---|---|---|---|---|---|
| | | LM120H-12 (TO-39) | | | LM320H-12 (TO-39) | | | |
| Design Output Current ($I_D$) Device Dissipation ($P_D$) | | 0.2A 2W | | | | | | |
| **Parameter** | **Conditions** (Note 6) | **Min** | **Typ** | **Max** | **Min** | **Typ** | **Max** | |
| Input Voltage | | −32 | | −14 | −32 | | −14 | V |
| Ripple Rejection | f = 120 Hz | 56 | 80 | | 56 | 80 | | dB |
| Load Regulation, (Note 7) | $T_J$ = 25°C, $V_{IN}$ = 17V, 5 mA ≤ $I_{LOAD}$ ≤ $I_D$ | | 10 | 25 | | 10 | 40 | mV |
| Output Voltage, (Note 6) | 14.5V ≤ $V_{IN}$ ≤ $V_{MAX}$, 5 mA ≤ $I_{LOAD}$ ≤ $I_D$, P ≤ $P_D$ | −12.5 | | −11.5 | −12.6 | | −11.4 | V |
| Quiescent Current | $V_{MIN}$ ≤ $V_{IN}$ ≤ $V_{MAX}$ | | 2 | 4 | | 2 | 4 | mA |
| Quiescent Current Change | $T_J$ = 25°C | | | | | | | |
| | $V_{MIN}$ ≤ $V_{IN}$ ≤ $V_{MAX}$ | | 0.05 | 0.4 | | 0.05 | 0.4 | mA |
| | 5 mA ≤ $I_{LOAD}$ ≤ $I_D$ | | 0.03 | 0.4 | | 0.03 | 0.4 | mA |
| Output Noise Voltage | $T_A$ = 25°C, $C_L$ = 1 µF, $I_L$ = 5 mA, $V_{IN}$ = 17V, 10 Hz ≤ f ≤ 100 kHz | | 400 | | | 400 | | µV |
| Long Term Stability | | | 12 | 120 | | 12 | 120 | mV |
| Thermal Resistance | | | | | | | | |
| Junction to Case | | | | (Note 8) | | | (Note 8) | °C/W |
| Junction to Ambient | | | | (Note 8) | | | (Note 8) | °C/W |

## −12 Volt Regulators Electrical Characteristics

| Order Numbers | | Power Plastic Package | | | Units |
|---|---|---|---|---|---|
| | | LM320T-12 (TO-220) | | | |
| Design Output Current ($I_D$) Device Dissipation ($P_D$) | | 1A 15W | | | |
| **Parameter** | **Conditions** (Note 6) | **Min** | **Typ** | **Max** | |
| Output Voltage | $T_J$ = 25°C, $V_{IN}$ = 17V, $I_{LOAD}$ = 5 mA | −12.4 | −12 | −11.6 | V |
| Line Regulation | $T_J$ = 25°C, $I_{LOAD}$ = 5 mA, $V_{MIN}$ ≤ $V_{IN}$ ≤ $V_{MAX}$ | | 4 | 20 | mV |
| Input Voltage | | −32 | | −14.5 | V |
| Ripple Rejection | f = 120 Hz | 56 | 80 | | dB |
| Load Regulation, (Note 7) | $T_J$ = 25°C, $V_{IN}$ = 17V, 5 mA ≤ $I_{LOAD}$ ≤ $I_D$ | | 30 | 80 | mV |
| Output Voltage, (Note 6) | 14.5V ≤ $V_{IN}$ ≤ $V_{MAX}$, 5 mA ≤ $I_{LOAD}$ ≤ $I_D$, P ≤ $P_D$ | −12.6 | | −11.4 | V |
| Quiescent Current | $V_{MIN}$ ≤ $V_{IN}$ ≤ $V_{MAX}$ | | 2 | 4 | mA |
| Quiescent Current Change | $T_J$ = 25°C | | | | |
| | $V_{MIN}$ ≤ $V_{IN}$ ≤ $V_{MAX}$ | | 0.1 | 0.4 | mA |
| | 5 mA ≤ $I_{LOAD}$ ≤ $I_D$ | | 0.1 | 0.4 | mA |
| Output Noise Voltage | $T_A$ = 25°C, $C_L$ = 1 µF, $I_L$ = 5 mA, $V_{IN}$ = 17V, 10 Hz ≤ f ≤ 100 kHz | | 400 | | µV |
| Long Term Stability | | | 24 | | mV |

| Order Numbers | | Power Plastic Package<br>LM320T-12<br>(TO-220) | | | Units |
|---|---|---|---|---|---|
| Design Output Current ($I_D$)<br>Device Dissipation ($P_D$) | | 1A<br>15W | | | |
| **Parameter** | **Conditions** (Note 6) | **Min** | **Typ** | **Max** | |
| Thermal Resistance | | | | | |
| Junction to Case | | | 4 | | °C/W |
| Junction to Ambient | | | 50 | | °C/W |

**Note 6:** This specification applies over $-55°C \leq T_J \leq +150°C$ for the LM120 and $0°C \leq T_J \leq +125°C$ for the LM320.

**Note 7:** Regulation is measured at constant junction temperature. Changes in output voltage due to heating effects must be taken into account separately. To ensure constant junction temperature, low duty cycle, pulse testing is used. The LM120/LM320 series does have low thermal feedback, improving line and load regulation. On all other tests, even though power dissipation is internally limited, electrical specifications apply only up to $P_D$.

**Note 8:** Thermal resistance of typically 85°C/W (in 400 linear feet/min air flow), 224°C/W (in static air) junction to ambient, of typically 21°C/W junction to case.

**Note 9:** Refer to RETS120H-12 drawing for LM120H-12 or RETS120-12K drawing for LM120K-12 military specifications.

## Absolute Maximum Ratings

## −15 Volt Regulators (Note 13)

**If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.**

| | |
|---|---|
| Power Dissipation | Internally Limited |
| Input Voltage | |
| LM120/LM320 | −40V |
| LM320T | −35V |
| Input-Output Voltage Differential | 30V |
| Junction Temperatures | (Note 10) |
| Storage Temperature Range | −65°C to +150°C |
| Lead Temperature | |
| (Soldering, 10 sec.) | 300°C |

## −15 Volt Regulators Electrical Characteristics

| Order Numbers | | Metal Can Package | | | | | | Units |
|---|---|---|---|---|---|---|---|---|
| | | LM120K-15 (TO-3) | | | LM320K-15 (TO-3) | | | |
| Design Output Current ($I_D$) Device Dissipation ($P_D$) | | 1A 20W | | | | | | |
| **Parameter** | **Conditions** (Note 10) | **Min** | **Typ** | **Max** | **Min** | **Typ** | **Max** | |
| Output Voltage | $T_J = 25°C$, $V_{IN} = 20V$, $I_{LOAD} = 5$ mA | −15.3 | −15 | −14.7 | −15.4 | −15 | −14.6 | V |
| Line Regulation | $T_J = 25°C$, $I_{LOAD} = 5$ mA, $V_{MIN} \le V_{IN} \le V_{MAX}$ | | 5 | 10 | | 5 | 20 | mV |
| Input Voltage | | −35 | | −17 | −35 | | −17 | V |
| Ripple Rejection | f = 120 Hz | 56 | 80 | | 56 | 80 | | dB |
| Load Regulation, (Note 11) | $T_J = 25°C$, $V_{IN} = 20V$, $5\text{ mA} \le I_{LOAD} \le I_D$ | | 30 | 80 | | 30 | 80 | mV |
| Output Voltage, (Note 10) | $17.5V \le V_{IN} \le V_{MAX}$, $5\text{ mA} \le I_{LOAD} \le I_D$, $P \le P_D$ | −15.5 | | −14.5 | −15.6 | | −14.4 | V |
| Quiescent Current | $V_{MIN} \le V_{IN} \le V_{MAX}$ | | 2 | 4 | | 2 | 4 | mA |
| Quiescent Current Change | $T_J = 25°C$ | | | | | | | |
| | $V_{MIN} \le V_{IN} \le V_{MAX}$ | | 0.1 | 0.4 | | 0.1 | 0.4 | mA |
| | $5\text{ mA} \le I_{LOAD} \le I_D$ | | 0.1 | 0.4 | | 0.1 | 0.4 | mA |
| Output Noise Voltage | $T_A = 25°C$, $C_L = 1\ \mu F$, $I_L = 5$ mA, $V_{IN} = 20V$, 10 Hz ≤ f ≤ 100 kHz | | 400 | | | 400 | | μV |
| Long Term Stability | | | 15 | 150 | | 15 | 150 | mV |
| Thermal Resistance | | | | | | | | |
| Junction to Case | | | | 3 | | | 3 | °C/W |
| Junction to Ambient | | | | 35 | | | 35 | °C/W |

## −15 Volt Regulators Electrical Characteristics

| Order Numbers | | Metal Can Package | | | | | | Units |
|---|---|---|---|---|---|---|---|---|
| | | LM120H-15 (TO-39) | | | LM320H-15 (TO-39) | | | |
| Design Output Current ($I_D$) Device Dissipation ($P_D$) | | 0.2A 2W | | | | | | |
| **Parameter** | **Conditions** (Note 10) | **Min** | **Typ** | **Max** | **Min** | **Typ** | **Max** | |
| Output Voltage | $T_J = 25°C$, $V_{IN} = 20V$, $I_{LOAD} = 5$ mA | −15.3 | −15 | −14.7 | −15.4 | −15 | −14.6 | V |
| Line Regulation | $T_J = 25°C$, $I_{LOAD} = 5$ mA, $V_{MIN} \le V_{IN} \le V_{MAX}$ | | 5 | 10 | | 5 | 20 | mV |

| Order Numbers | | Metal Can Package | | | | | | Units |
|---|---|---|---|---|---|---|---|---|
| | | LM120H-15 (TO-39) | | | LM320H-15 (TO-39) | | | |
| Design Output Current ($I_D$) Device Dissipation ($P_D$) | | 0.2A 2W | | | | | | |
| **Parameter** | **Conditions** (Note 10) | **Min** | **Typ** | **Max** | **Min** | **Typ** | **Max** | |
| Input Voltage | | −35 | | −17 | −35 | | −17 | V |
| Ripple Rejection | f = 120 Hz | 56 | 80 | | 56 | 80 | | dB |
| Load Regulation, (Note 11) | $T_J = 25°C$, $V_{IN} = 20V$, $5\ mA \leq I_{LOAD} \leq I_D$ | | 10 | 25 | | 10 | 40 | mV |
| Output Voltage, | $17.5V \leq V_{IN} \leq V_{MAX}$, | −15.5 | | −14.5 | −15.6 | | | |

| Order Numbers | | Power Plastic Package | | | Units |
|---|---|---|---|---|---|
| | | LM320T-15 (TO-220) | | | |
| Design Output Current ($I_D$) | | 1A | | | |
| Device Dissipation ($P_D$) | | 15W | | | |
| **Parameter** | **Conditions** (Note 10) | **Min** | **Typ** | **Max** | |
| Thermal Resistance | | | | | |
| Junction to Case | | | 4 | | °C/W |
| Junction to Ambient | | | 50 | | °C/W |

**Note 10:** This specification applies over $-55°C \leq T_J \leq +150°C$ for the LM120 and $0°C \leq T_J \leq +125°C$ for the LM320.

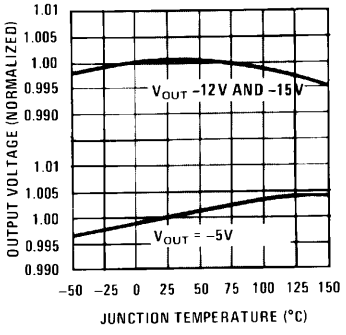
**Note 11:** Regulation is measured at constant junction temperature. Changes in output voltage due to heating effects must be taken into account separately. To ensure constant junction temperature, low duty cycle, pulse testing is used. The LM120/LM320 series does have low thermal feedback, improving line and load regulation. On all other tests, even though power dissipation is internally limited, electrical specifications apply only up to $P_D$.

**Note 12:** Thermal resistance of typically 85°C/W (in 400 linear feet/min air flow), 224°C/W (in static air) junction to ambient, of typically 21°C/W junction to case.

**Note 13:** Refer to RETS120-15H drawing for LM120H-15 or RETS120-15K drawing for LM120K-15 military specifications.

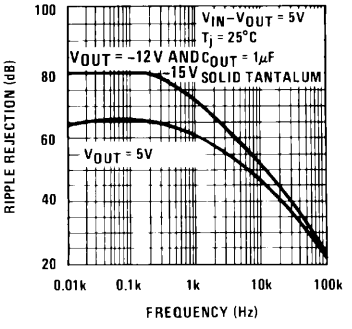
# Typical Performance Characteristics

**Output Voltage vs Temperature**

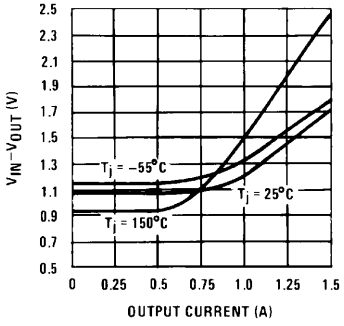



776720

**Ripple Rejection (All Types)**

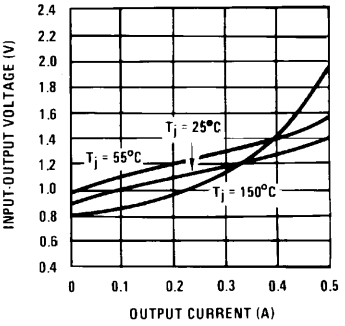


**Minimum Input-Output Differential TO-3 and TO-220 Packages**



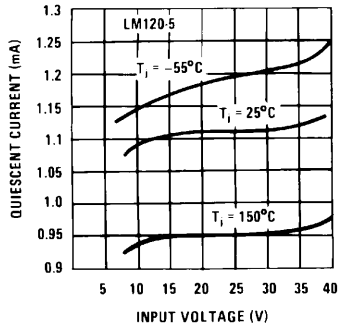

776724

**Minimum Input-Output Differential TO-5 and TO-202 Packages**



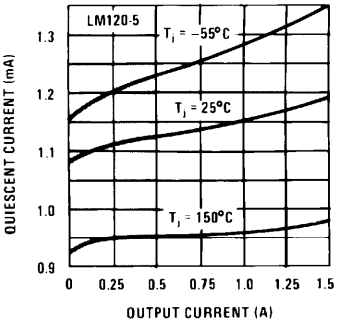

776725

**Quiescent Current vs Input Voltage**



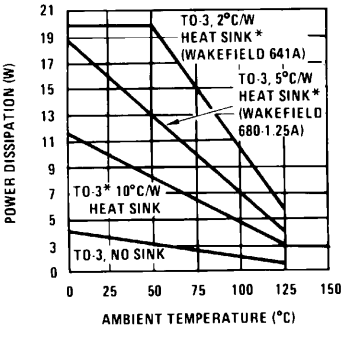

776726

**Quiescent Current vs Load Current**




776727

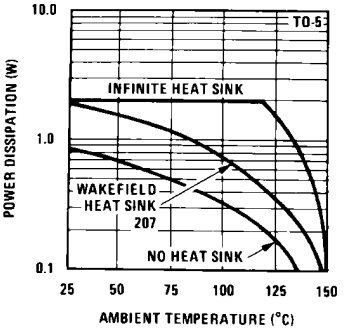
**Maximum Average Power Dissipation (TO-3)**


POWER DISSIPATION (W)
AMBIENT TEMPERATURE (°C)
TO-3, 2°C/W HEAT SINK* (WAKEFIELD 641A)
TO-3, 5°C/W HEAT SINK* (WAKEFIELD 680-1.25A)
TO-3* 10°C/W HEAT SINK
TO-3, NO SINK

776728

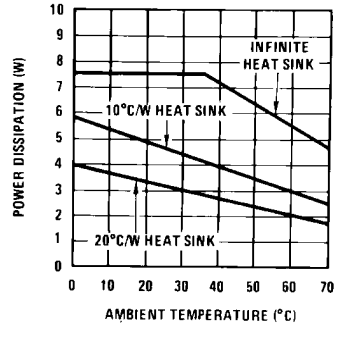
*These curves for LM120. Derate 25°C further for LM320.

**Maximum Average Power Dissipation (TO-5)**



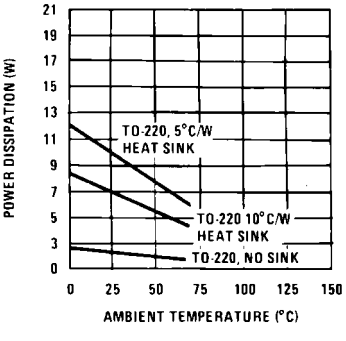

776729

**Maximum Average Power Dissipation (TO-202)**



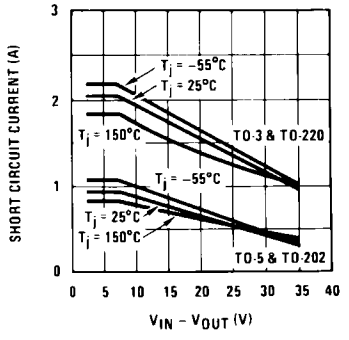

776730

**Maximum Average Power Dissipation (TO-220)**




776731

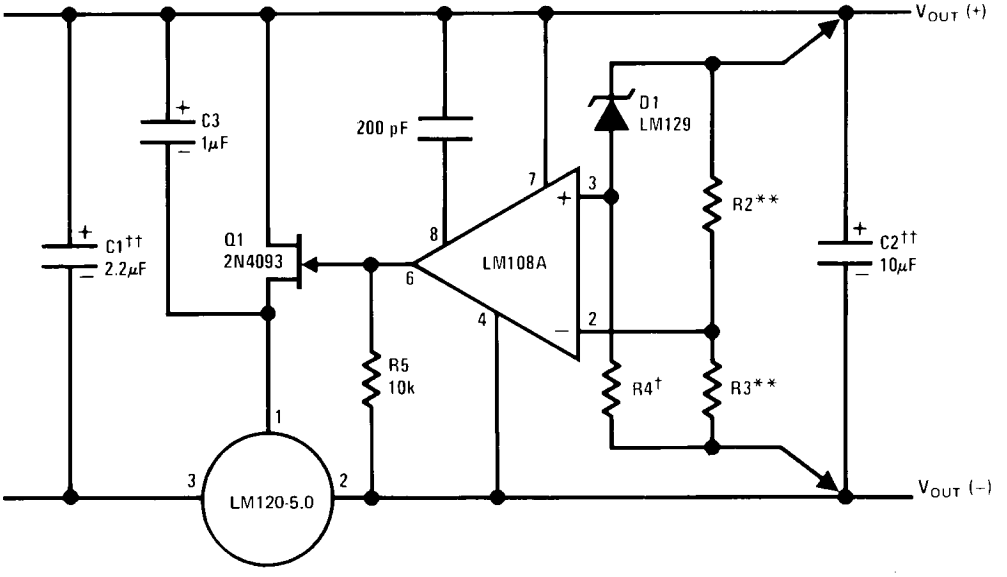
**Short Circuit Current**




776732

# Typical Applications

### High Stability 1 Amp Regulator




776706

Lead and line regulation — 0.01% temperature stability — 0.2%

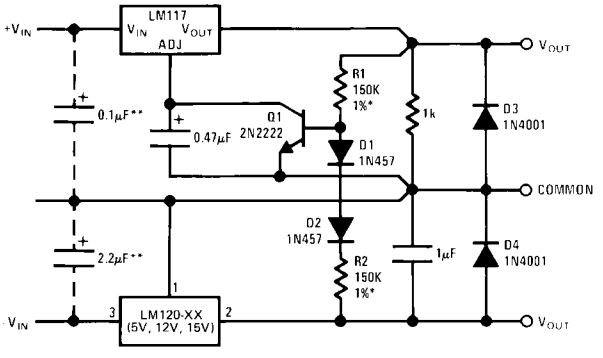
†Determines Zener current.

††Solid tantalum.

An LM120-12 or LM120-15 may be used to permit higher input voltages, but the regulated output voltage must be at least −15V when using the LM120-12 and −18V for the LM120-15.

**Select resistors to set output voltage. 2 ppm/°C tracking suggested.

### Wide Range Tracking Regulator



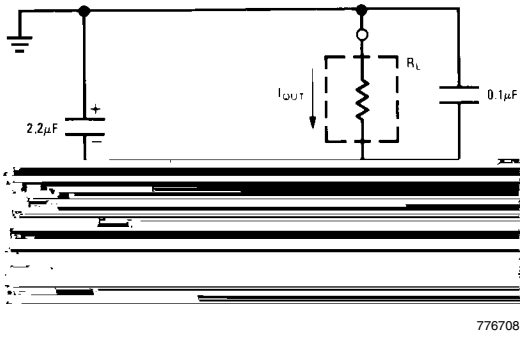

776707

*Resistor tolerance of R1 and R2 determine matching of (+) and (−) inputs.

**Necessary only if raw supply capacitors are more than 3″ from regulators

An LM3086N array may substitute for Q1, D1 and D2 for better stability and tracking. In the array diode transistors Q5 and Q4 (in parallel) make up D2; similarly, Q1 and Q2 become D1 and Q3 replaces the 2N2222.

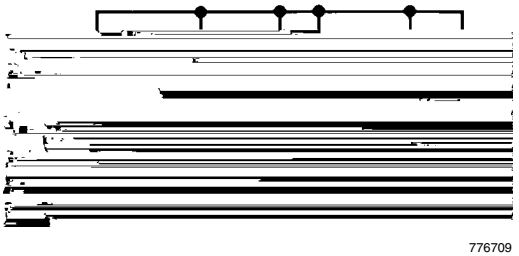
### Current Source




776708

$$*I_{OUT} = 1\ mA + \frac{5.0V}{R1}$$

### Variable Output Current Source



776709

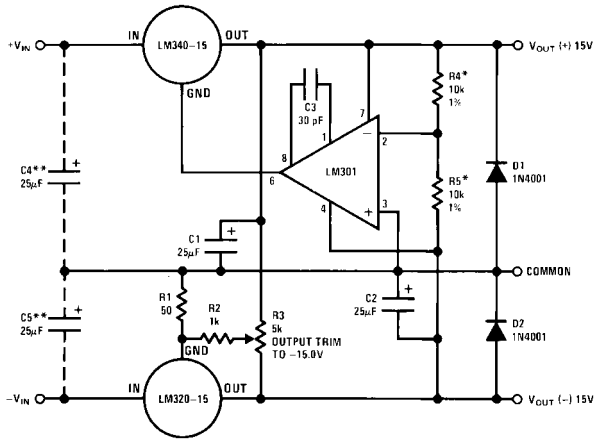
**SELECT R2 AS FOLLOWS:**

| | |
|---|---|
| **LM120-5** | **300Ω** |
| **LM120-12** | **750Ω** |
| **LM120-15** | **1k** |

$$V_{OUT} = V_{SET}\frac{R1 + R2}{R2}$$

*C3 optional. Improves transient response and ripple rejection.

### ±15V, 1 Amp Tracking Regulators



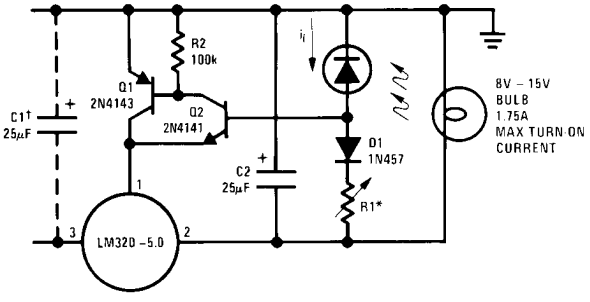

776712

**Performance (Typical)**

| | | |
|---|---|---|
| Load Regulation at $\Delta I_L$ = 1A | 10 mV | 1 mV |
| Output Ripple, $C_{IN}$ = 3000 μF, $I_L$ = 1A | 100 μVrms | 100 μVrms |
| Temperature Stability | +50 mV | +50 mV |
| Output Noise 10 Hz ≤ f ≤ 10 kHz | 150 μVrms | 150 μVrms |

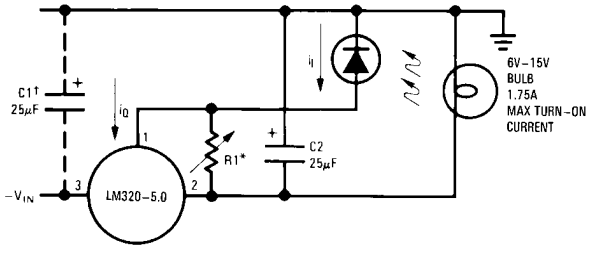
*Resistor tolerance of R4 and R5 determine matching of (+) and (–) outputs.
**Necessary only if raw supply filter capacitors are more than 2 inches from regulators.

### Light Controllers Using Silicon Photo Cells




776710

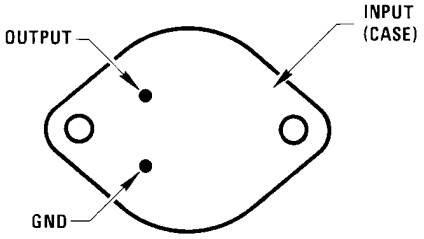
*Lamp brightness increases until $i_I$ = 5V/R1 ($i_I$ can be set as low as 1 μA).
†Necessary only if raw supply filter capacitor is more than 2 inches from LM320MP.




776711

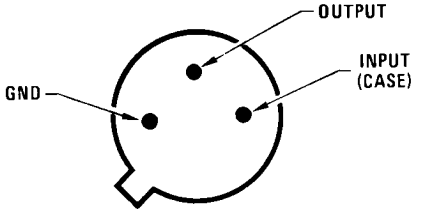
*Lamp brightness increases until $i_I = i_Q$ (1 mA) + 5V/R1.
†Necessary only if raw supply filter capacitor is more than 2 inches from LM320.

## Connection Diagrams



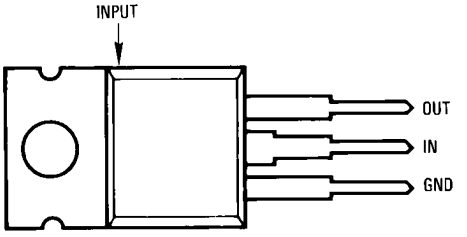

776714

**Bottom View**
**Steel Metal Can Package TO-3 (K)**
**Order Number LM120K-5.0/883, LM120K-12/883, LM120K-15/883, LM320K-5.0, LM320K-12 or LM320K-15**
**See NS Package Number K02A**




776713

**Bottom View**
**Metal Can Package TO-39 (H)**
**Order Number LM120H-5.0, LM120H-12, LM120H-15, LM120H-5.0/883, LM120H-12/883, LM120H-15/883, LM320H-5.0, LM320H-12 or LM320H-15**
**See NS Package Number H03A**

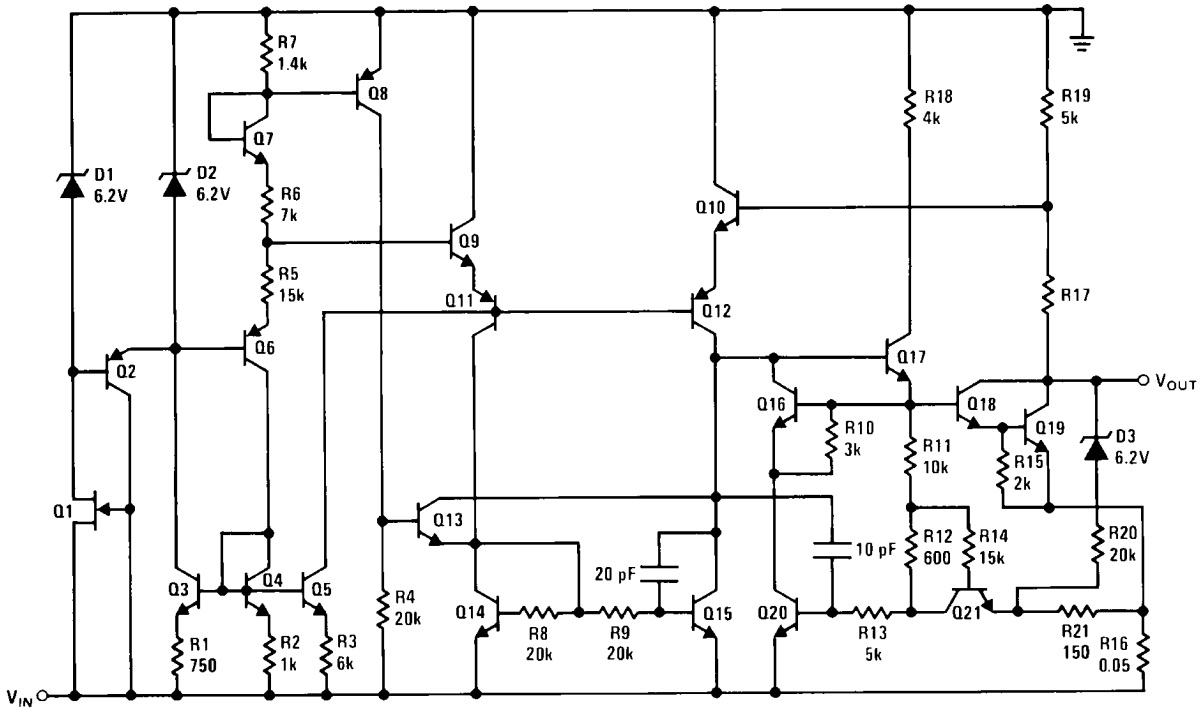



776717

**Front View**
**Power Package TO-220 (T)**
**Order Number LM320T-5.0, LM320T-12 or LM320T-15**
**See NS Package Number T03B**

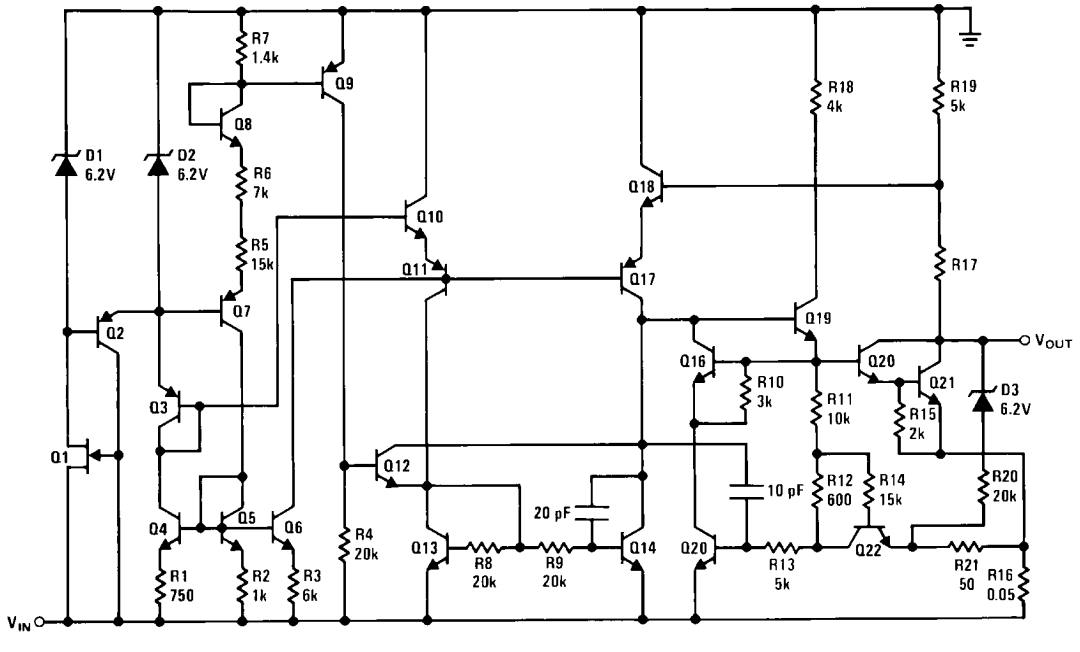
## Schematic Diagrams

**−5V**



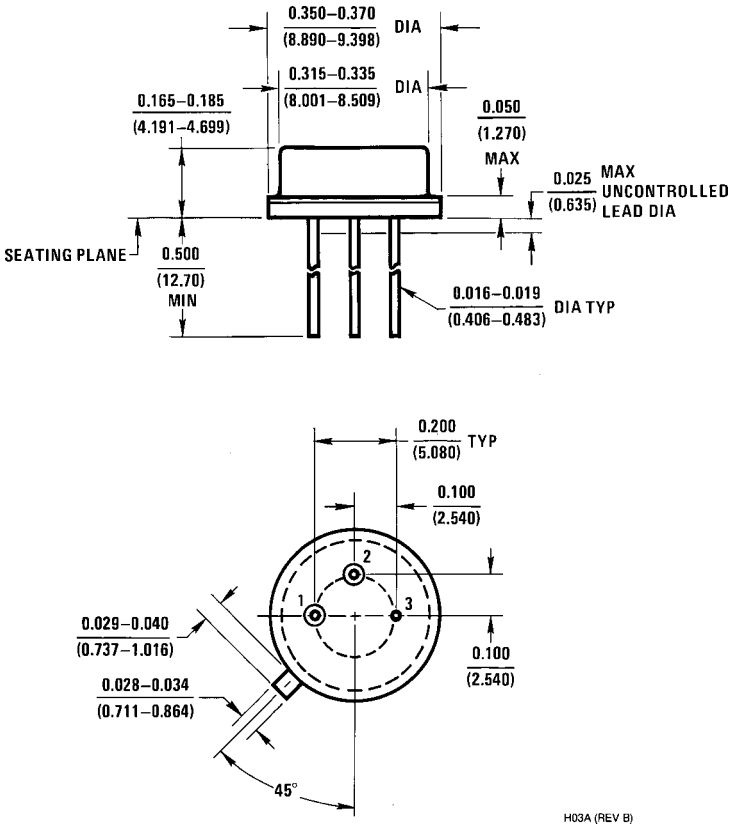

776718

**−12V and −15V**

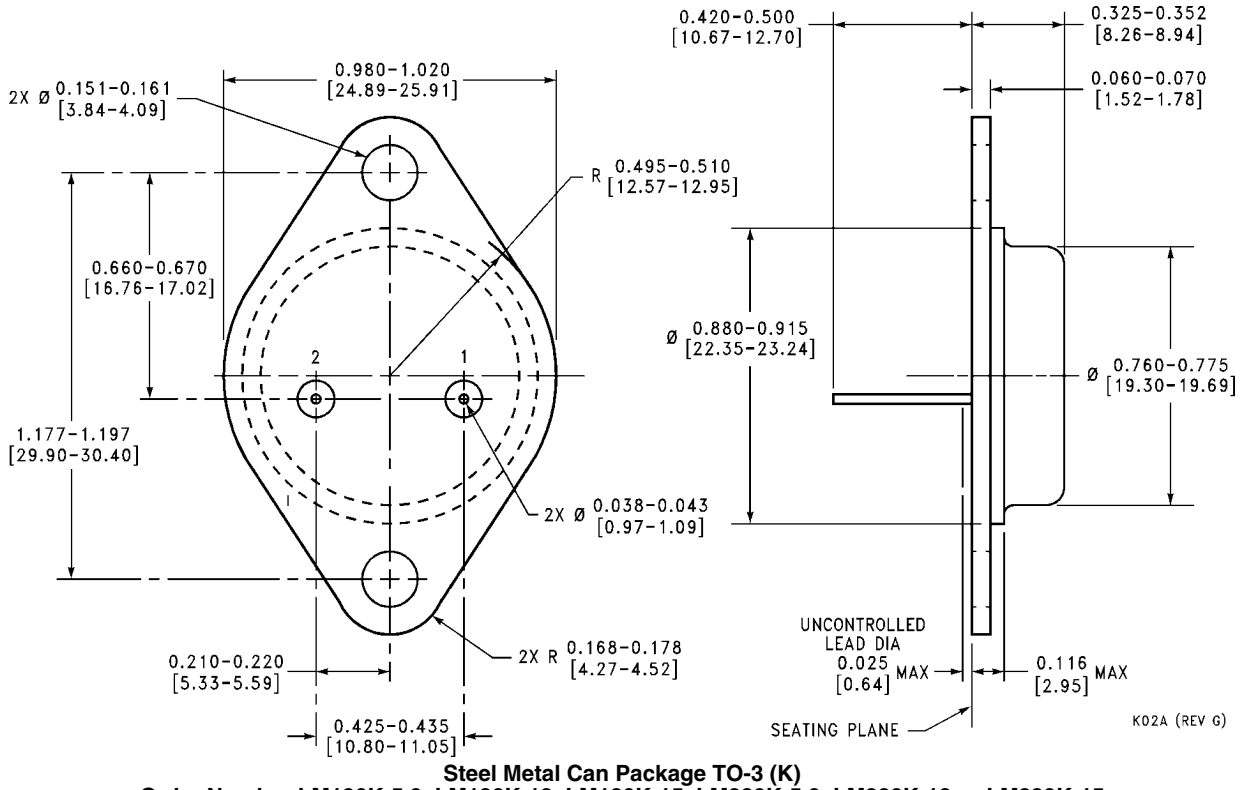



776719

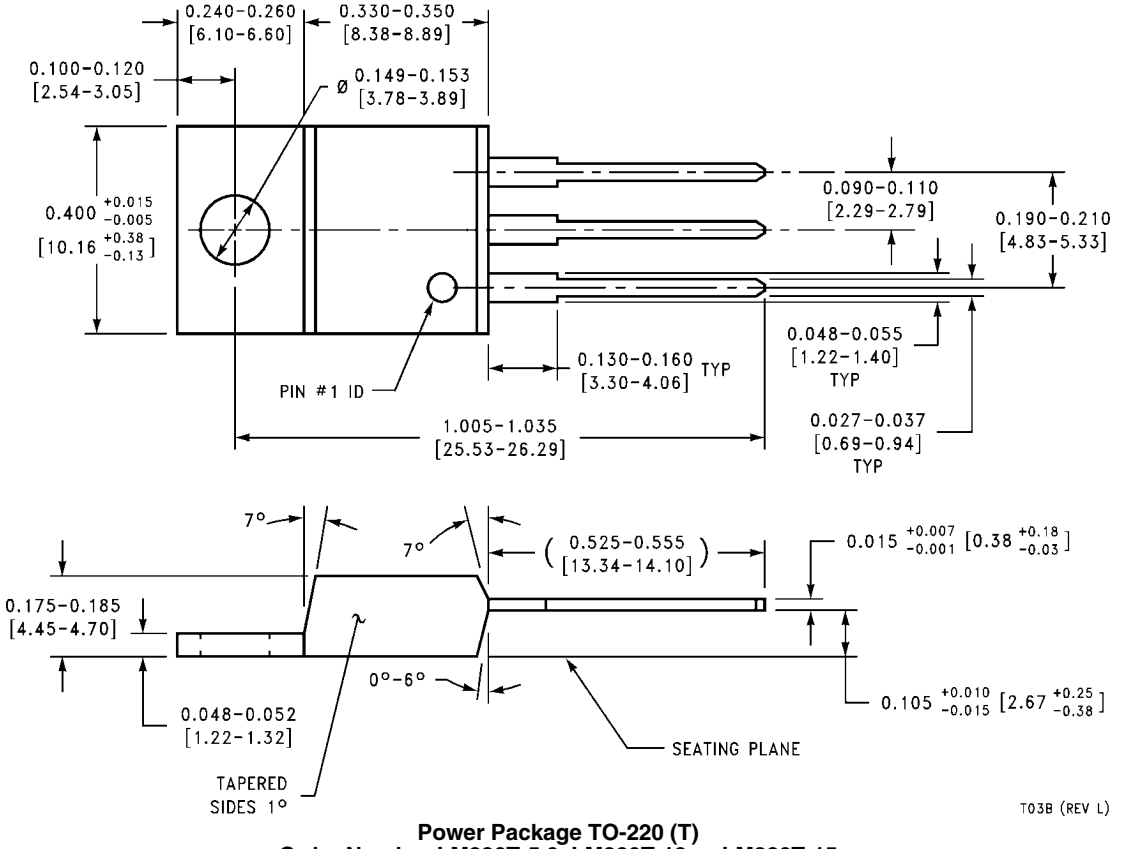
## Physical Dimensions inches (millimeters) unless otherwise noted




**Metal Can Package (TO-39) (H)**
**Order Number LM120H-5.0, LM120H-12, LM120H-15, LM320H-5.0, LM320H-12 or LM320H-15**
**NS Package Number H03A**




**Steel Metal Can Package TO-3 (K)**
**Order Number LM120K-5.0, LM120K-12, LM120K-15, LM320K-5.0, LM320K-12 or LM320K-15**
**NS Package Number K02A**




**Power Package TO-220 (T)**
**Order Number LM320T-5.0, LM320T-12 or LM320T-15**
**NS Package Number T03B**

# Notes

# Notes

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